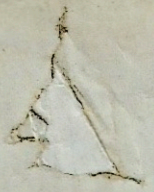
PHILIPS'
POCKET SURVEYOR

DESIGNED BY

GEORGE C. SHERRIN



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We now measure BE and E*a*, and the position of *a* is fixed. Similarly *b* is found by dropping a perpendicular *b*F and measuring EF and F*b*. In like manner not only can the contour be put on paper, but also the boundaries of the field. In fact, if we take the illustration to Example 7, it would be no difficult matter not only to find the area as in that example, but also to show the exact position of the field gate, the size and position of the pond, the position and height of the tree, and the contour of the piece of rising ground. In other words, a complete map of the field could be made, using no other instrument than the Pocket Surveyor.

These few pages, which have been written merely to indicate the uses to which the Pocket Surveyor can be put, have of necessity omitted many technical points of great interest and should be supplemented with text-books on Surveying.

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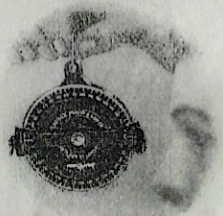
Philips'
Handy Theodolite

Designed by G. C. SHERRIN



A new pocket instrument, compact, convenient and durable; of practical value for a variety of purposes, such as taking levels, measuring heights and gradients, etc., etc. Size 4¼ inches diameter. Beautifully moulded in ebonite composition with nickel-plated parts. Supplied in leatherette case, with explanatory pamphlet ... **17s. 6d. net**

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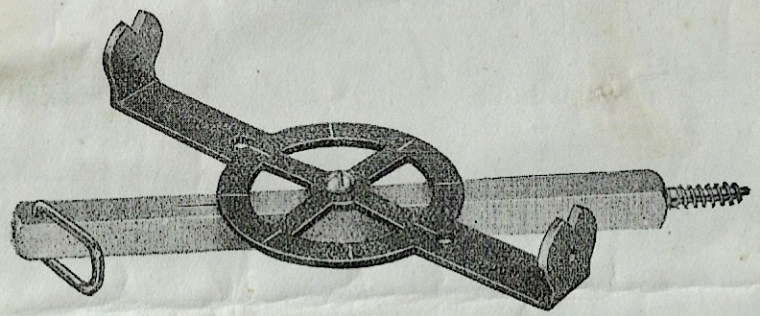
THE POCKET SURVEYOR



INTRODUCTION

THE Pocket Surveyor is an instrument for surveying the land. It does much the same kind of work that a theodolite does; but whereas the theodolite is a highly technical and a very expensive instrument the Pocket Surveyor is cheap and so simple that it can be used by anybody.

How difficult it has always been for the ordinary man to estimate for instance the height of a tall tree, to compare his level with that of the surrounding country, to measure the acreage of a meadow or even to lay out a right angle in his garden unless he has had an expensive instrument to help him!

The Pocket Surveyor now comes to his assistance and gives him just as much of an instrument as is absolutely necessary and one which requires no mathematics beyond the simplest arithmetic. It does not pretend to the minute accuracy of an expensive instrument, but when carefully used its accuracy is more than ample for his requirements.

When used as a level it can be set to as great precision as can be read by the unaided eye.

The circular scale has been divided only at every 45°, as it is found that further division is very seldom required, unless trigonometry is to be employed.

To convert the instrument from a level to a cross-staff the main arm has been terminated with a screw by which it can be readily fixed horizontally to the top of a suitable pole or even to the handle of a walking-stick.

The sight is a carefully considered compromise. The customary slot and hair-line have been abandoned for the advantages of a double-ended sight. This makes the checking of levels very simple, while when used as a cross-staff in the field the two V-grooves used together afford a very easy reading from either direction.

A few examples of the many uses of the Pocket Surveyor are set out in the following pages.

No. 1.—How to Compare Levels

Set the sight at right angles to the staff. Hold the instrument by the ring so that it is *perfectly free to swing*. Bring the sight close up to the eye and look

through the small pin-hole. Every object which can be seen within the apex of the opposite V-groove is on a level with your eye.

To verify this take a second reading, this time putting the other end of the sight to your eye. If the same objects are again visible within the apex of the V-groove your instrument is absolutely accurate. If

Using the Surveyor as a Level.

the objects seen in the second reading are above or below those of the first reading the true level is the mean of the two readings. In this case the sight should be slightly adjusted on the staff until both readings are identical.

For greater precision the distant object may be viewed through both pin-holes simultaneously.

No. 2.—How to Find the Height of a Tree or of a Building

Turn the sight to an angle of 45° so that it points upwards. Adjust your position relative to the tree so that the topmost branch just appears within the V-groove. The height of the tree, assuming that the

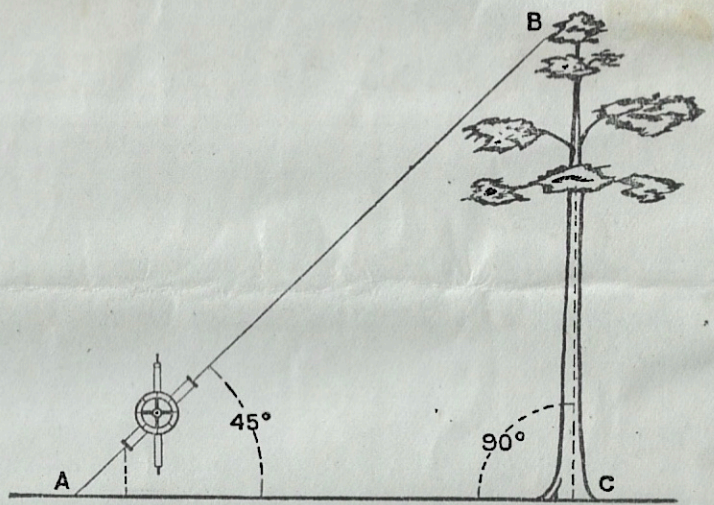


Fig. 1.—Measuring the Height of a Tree.

ground is about level, is equal to the distance you have to stand away from the tree added to your own height up to your eye. In other words, the height of the tree CB is equal to CA.

Note.—To find your exact height when observing take a level reading close up to a wall. Mark the point on the wall which is in view when you stand normally, and measure the height of the point from

the ground. Make a note of the measurement in your pocket-book, it will be of great service later on.

No. 3.—How to Find the Gradient of a Road

Many hills encountered on the road when motoring are very deceptive: some which appear steep are very easily climbed, and others which appear easy sometimes require a change of gear. The delusion is probably caused by the contour of the surrounding country.

To measure a gradient on the road stand at the bottom of the gradient and take a level reading. Observe what point on the road is level with your eye.

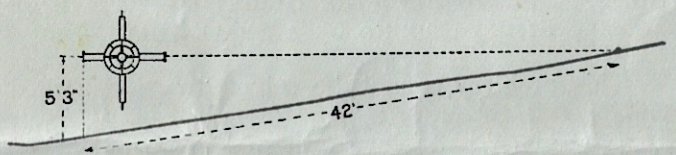


Fig. 2.—Finding the Gradient of a Road.

Measure the distance from where you stand to the point observed. Let us assume that it measures 42 ft. and that your own height up to your eye is 5 ft. 3 in. The gradient therefore will be $5\frac{1}{4}$ ft. in 42 ft., or 1 in 8.

This method, though not strictly accurate, gives a useful approximation.

Note.—How to measure distance by pacing.—As it is not always convenient to carry a tape-measure or a surveyor's chain to measure distance it is useful to know how to pace. Accurate pacing is a matter of practice, and the best way to practise is to measure out with a tape, in some suitable place, a distance, say, of 99 ft. Fix a peg at either end of the distance. Now, starting with the right heel against one of the pegs, march with a bold even stride to the second peg,

counting your paces as you go. When you are able to march the distance *repeatedly* in 33 strides you are pacing yards. It is not at all a difficult achievement for the average man.

In the case of boys whose normal pace is shorter it is not advisable to force the stride to a yard, as this invariably leads to error. It is better for him to find out how many of his normal paces go to 100 ft., or alternatively, how many feet or yards he covers in 50 normal paces. A note of it should be made in his pocket-book lest he forget.

No. 4.—How to Find the Height of a Piece of Rising Ground or a Small Hill

This problem cannot be solved by the method employed in No. 2 for finding the height of a tree, as

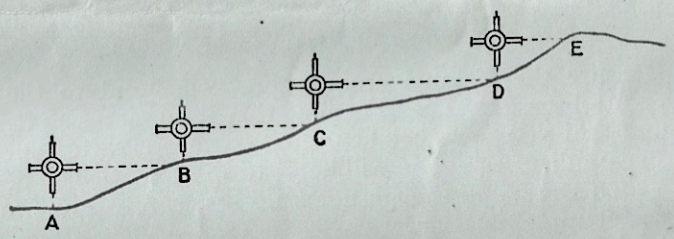


Fig. 3.—Measuring the Height of a Hill.

obviously we cannot produce a similar triangle. The method to be employed now is to stand at A, the bottom of the rise, and to take a level reading, which we will assume strikes the hill at B. We now proceed to B (it is not necessary to measure AB) and take a second level reading to C; from C we level to D, and finally to E, the top of the rise.

The height of the top of the rise above A is therefore 4 times your observing height, say, 4 × 5 ft. 3 in., which equals 21 ft.

No. 5.—How to Set out a Right Angle, *e.g.* for a Tennis Court, a Football Field, a Boys' Encampment, a Building, etc.

The instrument in the last four examples has been used as a level and a clinometer; it will now be used as a cross-staff. It will be observed there is a screw

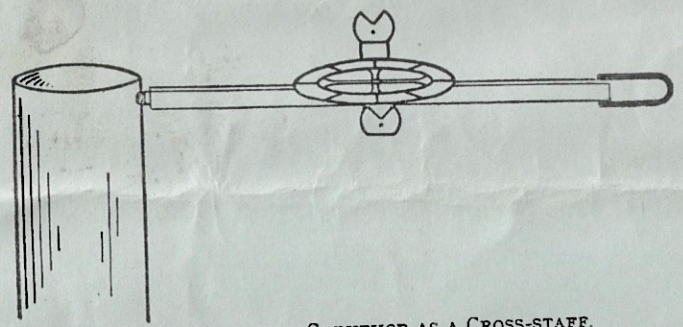


Fig. 4.—Using the Surveyor as a Cross-staff.

at the bottom of the instrument; this should be screwed into the top of a wooden pole 4 ft. to 5 ft. long (such as a broom-handle), so that the sight turns in a horizontal plane.

To set out a tennis court, for instance, one side of it or one base-line will probably be determined by the surrounding features of the lawn.

Let us assume that AB, Fig. 5, represents this side. The problem is to find the direction of the base-line of the court so that angle ABC (or the angle at B) is exactly a right angle.

Set up the pole, with the instrument attached, at a point D a few inches inside the court, so that the centre of the sight is vertically over the corner of the court. Set the sight at one of the divisions on the circular scale. Now look through the *two V-grooves* of the sight towards A and twist the pole at D slightly right or left until the point A is seen through the sight.

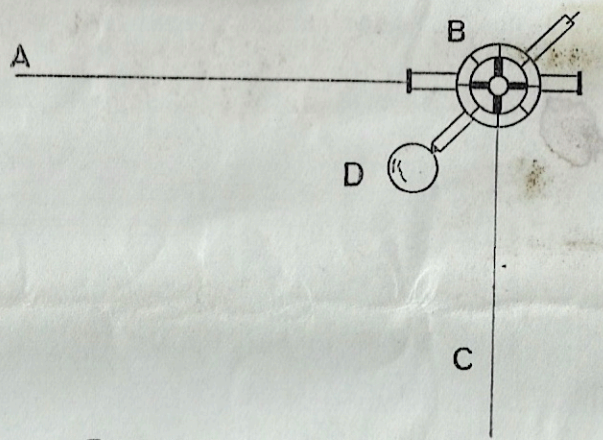


FIG. 5 —SETTING OUT A TENNIS COURT.

To obtain the direction of the base-line it is now only necessary to turn the sight through 90° and to take a second reading in the direction ot C. This direction must be marked with a stake, which should be visible through the sight.

NO. 6.—HOW TO FIND THE BREADTH OF A RIVER FROM ONE BANK

Let us say we wish to find the distance across the river from A to B, Fig. 6.

Set up the Surveyor (as in the previous example) at A so that B can be seen through the two V-grooves of the sight.

Turn the sight through 90° along the line AC and get an assistant to put a pole in the ground at C so that it can be seen through the sight from A.

Now take a sight in the opposite direction and let your assistant set up a second pole at D.

The line DC is now at right angles to AB.

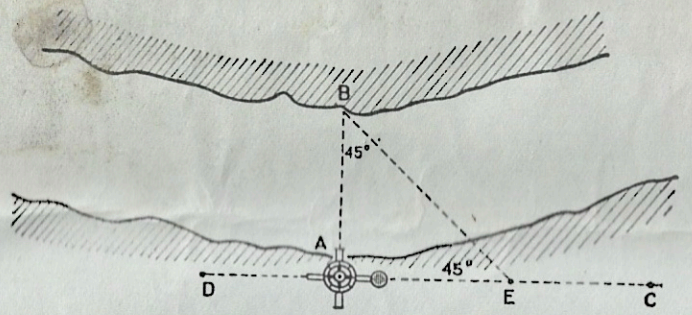


FIG. 6.—MEASURING THE BREADTH OF A RIVER FROM ONE BANK.

Now move the instrument along the line AC a distance which you estimate is equal to the breadth of the river—say, to the point E.

Again pick up D and C in the sight simultaneously. When this is done turn the sight through 45°. Should it now be possible to sight B it will follow that AE is equal to AB, and it is only necessary to measure AE to determine the distance A to B.

Should, however, it not be possible to sight B from the point E another attempt must be made by trying another point along AC until the desired conditions are obtained.

No. 7.—How to Find the Area of a Field

The secret of finding the area of a piece of land is to divide it into triangles and to measure up each triangle separately.

A good plan is to make a rough sketch of the field you intend to measure and to write on it the dimensions as you take them, as suggested in the diagram ABCE, Fig. 7.

Assuming for the sake of a simple example that the boundaries of the field are approximately straight lines, we may divide the field into two triangles, ABC and ACE, of which we will only deal with one.

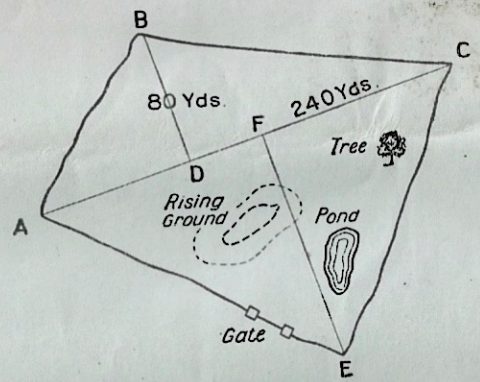


Fig. 7.—Measuring the Area of a Field.

Let us take that part of the field represented by ABC. If we can measure the length of AC and then find and measure the length of BD, the perpendicular on AC from B, we can at once find the area by multiplying AC by BD and dividing by 2 :

$$\frac{AC \times BD}{2} = \text{the area of ABC.}$$

First, then, we must measure by tape, chain, or pacing the line AC, *i.e.* from one corner of the field to the opposite corner. We will say it measures 240 yds. ; write this on our sketch.

Next we must set up the Surveyor, as in the last two examples, along the line AC and as nearly as we can judge opposite to B.

Having got the sight in line with A and C we turn it through 90° and try whether we can sight B. Probably B will fall to the right or left, perhaps by a considerable distance. The instrument must therefore be shifted to the right or left along AC until the actual point D is discovered.

Having obtained D we may proceed to measure DB, which we will say is 80 yds. Let 80 yds. be entered on the sketch.

The area of the triangle therefore equals $\frac{80 \times 240}{2}$ sq. yds., which works out to 9,600 sq. yds., or a little less than 2 acres.

In a similar manner the other part of the field represented by ACE may also be measured and the total area of the field found by adding the two triangles together.

To check the measurements it is good practice to measure the other sides of the triangle, as AB and BC, and also AD, and afterwards to plot out the triangle to scale upon paper. This will show at once whether any of the measurements are wrong.

Note.—In connection with the pond in the field, or the river in No. 6, or with any piece of water, it is useful to remember that the reflection seen in water of any object which is level with the eye is exactly halfway between the object and the observer.

No. 8.—How to Make a Simple Contour

A contour line, as will be observed by examining any map of the country, is a line joining all points of the same height above sea-level; a number, such as 50 or 100, written along the contour line means

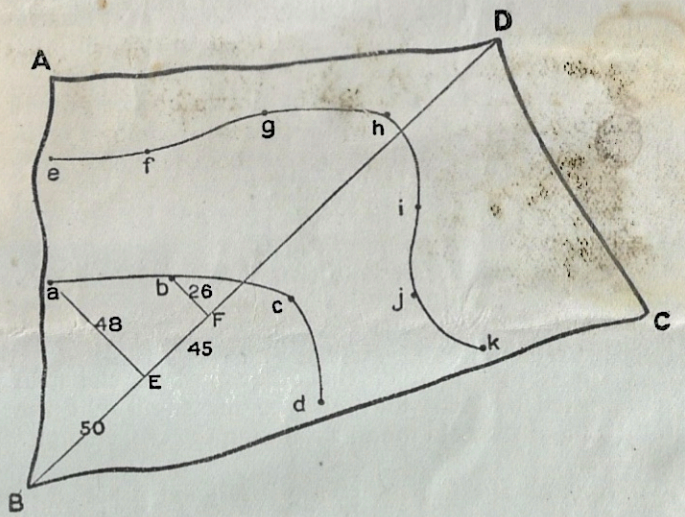


Fig. 8.—Contouring a Meadow.

that all places on the line are 50 ft. or 100 ft. above sea-level.

For a practical exercise let us contour the meadow shown in Fig. 8.

ABCD represents the meadow, which may be of, perhaps, 5 or 6 acres.

The reason for contouring in this case may be that the farmer wishes to lay surface drains to drain the soil of excessive rain-water.

On entering the meadow we shall observe that the point B is probably the lowest point.

Set the theodolite to show levels, as in No. 1, and standing at B take a level towards A. We shall find that a point *a* is on a level with the eye. Get an assistant to mark *a* on the ground with a small stake or to peg down a piece of white paper. Now turn the theodolite to another point level with the eye, such as *b*, and then to some point *c*, and then to *d*, each point being marked on the ground.

If now an imaginary line be drawn on the ground through *a*, *b*, *c*, and *d* it will represent a contour 5 ft. 3 in. above the point B—5 ft. 3 in. being the observer's height.

A second contour may now be made by standing at some convenient point on the first contour and again taking levels, which meet the ground, say, at *e*, *f*, *g*, *h*, *i*, *j*, and *k*. The line drawn through these points will be a contour 10 ft. 6 in. above the point B.

Should it be desirable to form contours, say, at every foot, or to find the exact height of any particular point on the ground, it is necessary to use a staff marked off in feet, which must be held in position by an assistant.

Contouring, therefore, is a simple operation; what is more difficult is to plot the contours on paper, or in other words, to make a plan or map of the meadow with the contours marked upon it.

To do this we shall of course have to measure up the meadow. As in Example 7, a base-line must be set out from B to D and the points in the contour, *a*, *b*, *c*, etc., measured in relation to this line.

For instance, the point *a* is 50 ft. along BD and 48 ft. at right angles to the left of BD.

As in Example 7, a perpendicular must be drawn from *a* to BD, which we will assume meets BD at E.